Carbon Dioxide Fixed Fire Fighting System Service & Operations Checks Guide

A fixed CO_2 fire fighting system when outfitted on a vessel can be one of the most important safety systems relied upon. A properly maintained and serviced CO_2 system can provide the means for swift fire control in seconds as well as the last defense in saving lives and the vessel itself. Even though there are many advantages for the use of CO_2 in the marine industry, it is just as important to recognize a serious disadvantage: People will suffocate in a CO_2 environment. Therefore, CO_2 must be used properly to be effective.

Human error can be related to the majority of accidents and casualties associated with CO_2 systems. Whether it be lack of communicating, unfamiliarity with system devices for operations, lack of understanding by a crew, or panic during an emergency; any or all can lead to a deadly consequence. For those reasons, it is equally important for those who may need to use a CO_2 system to understand basic servicing and operation checks.

This guide and associated checklist has been prepared primarily for owners, operators and crewmembers to use when witnessing CO_2 systems being serviced in an effort to: 1) Prevent injuries and fatalities due to accidental discharge of CO_2, 2) Identify system problems that would otherwise go unnoticed; and 3) Increase working familiarity with the entire CO_2 system on a vessel.

****Servicing & system checks of fixed CO_2 systems must only be performed by qualified and authorized people of a company certified to work on a specific type and manufacturer of CO_2 system.****

Witnessing Your Fixed CO_2 System Servicing Checklist

1	Are spaces covered by CO_2 system clear of personnel?
2	Are the CO_2 bottles located outside the protected space?
3	Doors & other means of egress from a space protected by CO_2 open outward from the space.
4	CO_2 bottles hydrotested within last 12 years & at recharging.
5	Flex hose connecting bottles to piping hydrotested at recharging and every 12 years.
6	Connecting hoses not cracked/worn. Should not be bent over 90 degrees.
7	System piping intact. Ends extended at least 2 inches from last discharge nozzle.
8	Large bottles secured 2 inches off deck.
9	Check for instructions at activation stations (main bottle banks & remote operation pulls).
	After CO_2 bottles disconnected from system
10	Test remote operation pulls. NO excess play (over 14 inches) bottle(s) & stop valve pins should pop.
11	Test alarm & delay. (Delay 20 sec minimum; 30 sec normal)
12	Automatic vents shut down during alarm/delay test.
13	Check natural ventilation covers.
14	If heat sensor installed, check heat switch activation.
15	Use portable CO_2 bottle to check piping system and nozzle discharge.
16	Weigh or liquid gauge CO_2 bottles (recharge if less than 90%)

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Explanation of each item contained on following pages.

Supporting Comments

1. **Are spaces covered by CO_2 system clear of personnel?** The best way to avoid injuries & accidents is not have people in that space when a CO_2 system is being serviced. People have been killed when the servicing company accidentally discharged the system when servicing it. If keeping a space clear isn't practical (i.e. engine room, auxiliary machine room) then vacate the space while the bank of CO_2 bottles supplying that space are being disconnected and reconnected during servicing.

2. **Are CO_2 bottles located outside the protected space?** This is necessary so that manual activation at the bottles can be done without having to go into the burning space to activate the system. Locating the bottles outside the space also reduces the potential for system failure from the fire as well as bottles that may rupture from excessive heat expansion. Bottles should be secured in an area that are not subject to temperatures greater than 130 degrees F. Each bottle should also have a safety device (rupture disc) in the event of excessive pressure. The safety device allows for the pressure to bleed off from a single cylinder, leaving the rest of the bottles to still supply the system if needed. There is one exception to locating CO_2 bottles in a protected space; a system of 300 pounds or less with an auto activation release system is allowed.

3. **Do doors & other means of egress from a space protected by CO_2 open outwards?** This may be critical if a person is caught in a space when a **CO_2** system discharges. Increased pressure in a space from the discharge of a **CO_2** system can be enough to hold shut a door or hatch that opens inward to a space. This can effectively trap a person in a space or delay rescue personnel from entering the space.

4. **CO_2 bottles hydrotested within last 12 years & at recharging?** With any fixed CO_2 system, it is required the bottle be hydrostatically tested every 12 years. This differs from handheld portable CO_2 fire extinguishers, which require hydro testing every 5 years. It is also required that bottles be hydrotested after use and prior to being refilled. Hydrostatic testing is pressurizing a bottle with water to determine if the structural integrity remains intact. Hydro testing is done at a certified & approved facility. Check to find the hydro date stamped into the shoulder of the bottle.

5. **Flex hose connecting bottles to piping hydrotested at recharging and every 12 years?** This is the same idea that applied to testing the bottles. Servicing agency should provide documentation to show testing completed. Hose usually tested at a minimum of 1000 psi.

6. **Connecting hoses not cracked/worn. Should not be bent over 90 degrees?** Hoses are potentially the weak link in the system. They will be subject to the greatest pressure of the system upon activation. Bends over 90 degrees create a natural stress point which may compromise the strength of the hose. The stress to the hose is increased when the CO_2 system is activated.

7. **System piping intact. Ends extend at least 2 inches from the last discharge nozzle?** Check piping for cracks, rust or other damage that may affect the ability of the system to supply the CO_2 to the protected space. Piping ends should extend at least two inches beyond the nozzles. This allows the nozzles to remain clear of any debris that may be in the

piping. Also ensure that the nozzles are not located near ventilation ducts or openings. Nozzles located near these areas risk CO_2 being carried outside the protected space.

8. **Large bottles secured off deck 2 inches or more?** Check to see bottles for system are securely mounted. Mounting should be with brackets or retainers supplied by the manufacturer or the authorized servicing agency. Check to see if the bottles are not sitting on the deck. Water or contact with dissimilar metals can corrode the bottles or weaken the structural integrity.

9. **Check for instructions at activation stations (main bottle banks and remotes)?** At any place the system can be activated there should be simple operation & activation instructions posted. The instructions should be clearly visible and legible. Although this seems a simple item, missing operating instructions are a common discrepancy and may account for most accidental discharges.

DESIGN NOTE: Automatically activated systems should have automatically activated main engine and/or generator shutdowns, and automatic ventilation shutdowns and closures. Otherwise, automatic activation of the CO_2 system may not be effective if the engines remain running and the vents stay open.

10. **Test remote pulls. No excess play (over 14 inches). Bottle(s) & stop valve pins should pop.** Watch the discharge head(s) that were removed from the CO_2 bottles and stop valve. The discharge head is assembled to the top of the cylinder valve and contains a spring-loaded piston which when pressurized by carbon dioxide vapor is designed to depress the main check in the valve and discharge the contents of the cylinder. As remotes are pulled the activation pins in the discharge head(s) should extend (pop) out. All remote pulls should pull with 40 pounds of pressure or less.

11. **Test alarm & delay. (Delay 20 sec minimum/30 sec normal).** Normally tested with a portable CO_2 fire extinguisher hooked into the piping attached in front of the delay. Pipe plugs will be in place where the CO_2 cylinders hook into the piping system. Prior to testing, all system piping should be checked to see that no openings or loose fittings exist. Begin timing delay activation when the CO_2 extinguisher is discharged. Delay should last a least 20 seconds before the switch trips. The alarm should also be sounding during this time. The CO_2 system does not require ship's power to work. It is an independent system that operates on manual pulls and automatic heat sensors. The system is powered by the pressure of the CO_2 cylinders and the CO_2 agent itself.

12. **Automatic vents shut down during alarm/delay test.** If the space is protected by the CO_2 system has automatic vent shut downs, check to see that the motors for the ventilation have stopped. This is done immediately following the delay/alarm test. The automatic ventilation of the space should stop during the time of the delay/alarm test.

13. **Check natural ventilation covers.** If a space has natural ventilation, check to see that all vent ducts have covers to secure the flow of air. Vent covers and shut downs are important to the system, in that it is necessary to reduce/remove the flow of air to the fire. Also, vents can potentially carry away the CO_2 agent from the space being protected.

14. **If heat sensor installed, check heat switch activation.** Heat sensors are tested in two different ways. 1) Immerse the switch in hot/boiling water. Once the switch reaches the activation temperature, watch for the activation pin to pop at the cylinder bank. 2) Use of direct heating source (usually a propane torch). Care should be taken in use of direct heating not to damage the sensor—some sensors can only be tested using the hot water method. Again as the sensor reaches the activation temperature, watch for system activation pins to pop.

15. **Use portable CO_2 to check piping system and nozzle discharge.** A portable CO_2 extinguisher is connected directly to the piping system (the connection should not go through the delay or valve stop). CO_2 is best to use, it will help find any piping defects (cracks & leaks) and will be highly visible discharging from the nozzles. Check all piping for defects. Check nozzles for clear and unobstructed discharge of CO_2 agent.

16. **Weigh or liquid gauge CO_2 bottles (recharge if less than 90%).** Large CO_2 bottles do not have visual gauges to check contents in the bottles. These large bottles must be weighed or checked with a liquid gauge. Bottles must be within 10% of their fully charged weight. If the weight of the bottle is less than the 10% factor, then it must be recharged. The liquid gauge is an instrument that when placed around a bottle will indicate where the liquid level of the CO_2 agent is within the bottle. Liquid gauging is less precise and relies more heavily on the experience/training of the servicing agent. Observing liquid gauging, a fully charged bottle will appear to be 2/3 to 3/4 full.

*****NOTE***** In warm weather climates, CO_2 system bottles that can be exposed to temperatures greater than 130 degrees F should be filled to 80% of maximum to allow expansion of the CO_2 agent & avoid excessive pressure buildup.